

Robotics: A Consumer's Guide

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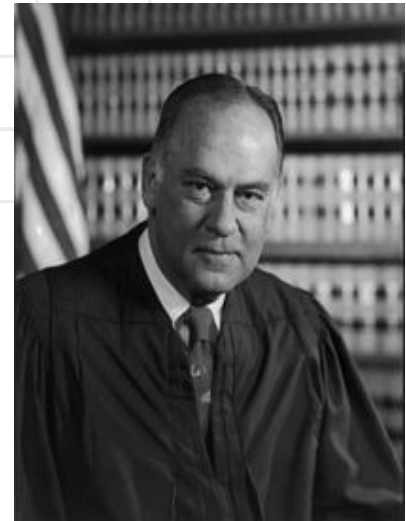


What is a Robot?

		Moving parts	Senses	Environment Acts on	Environment Responds to	Environment Remotely operated	Interacts with human	Follows algorithm	Makes its own decisions	Seems to have intent
Packbot		●	●	●	●					●
Roomba Vacuum		●	●	●	●		●	●		●
Industrial Arm		●	●	●	●		●	●		●
Calculator						●	●			
Security Light			●		●		●	●		
RC Car		●		●	●					
Washing machine		●	●	●	●		●	●		
Cruise Control		●	●	●	●	●	●	●		
Cruise Missile		●	●	●	●	●	●	●		
Printer		●	●	●	●	●	●	●		

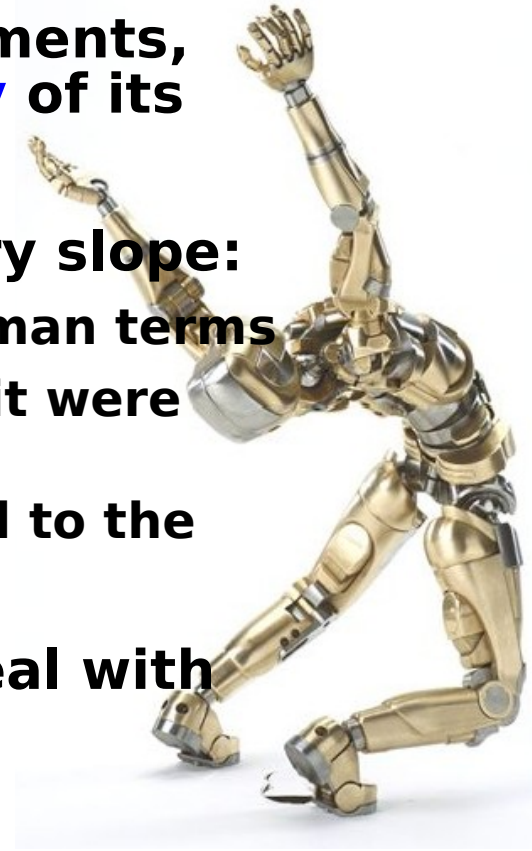
- Hard to define, yet we have strong opinions
- We know robots when we **see** them

*"I know it when I **see** it"*
Justice Potter Stewart 1964



The Slippery Slope

- A system which, by its appearance or movements, conveys a sense that it has **intent** or **agency** of its own
- Intent and agency entices us down a slippery slope:
 - Anthropomorphism: Thinking of robots in human terms
 - Reification fallacy: Abstraction treated as if it were real
 - Pathetic fallacy: Emotion or intent attributed to the inanimate
- May lead to poor decisions about how we deal with robots
 - Capabilities - what it can actually do
 - Expectations - what we expect it to do
 - Trust - how much we believe it will do the right thing



Your notion of intent may mislead you about what a robot is actually doing

Finding Intent Where There is None

“Wow, that thing threw a beer can right to him!”

- **Reification fallacy**

- “... threw ... to him!”
- **I know how hard it is to throw a can that far, this machine must be really smart.**

- **Worth only a B+ in undergrad mechatronics**



Beer-serving Robot

Dave Letterman Show

Learning New Models of Intent

- **She loves her new hybrid but is afraid s will hit a child in the driveway**
 - **Children know cars won't move until:**
 - **There is a driver in the seat**
 - **The engine is making noise**
 - **Hybrid cars violate this model**
- **When is it safe to walk around a large military robot?**
 - **You have eye contract with the driver?**
 - **No engine sounds are heard?**
 - **It is obvious that safe operation is inadvisable?**
 - **The big green light is flashing?**



Troops will need new models and cues to work effectively with robots

How You See the World

■ Sense

- Focus image in the eye
- Compress image in retina
- Transmit results to the brain

■ Compute

- Characterize the scene using a computation system evolved over millions of years
- Compare scene characteristics to a lifetime of stored experience

■ Act

- Select course of action that best satisfies the myriad goals of a living human



How a Robot Might See the World

■ Sense

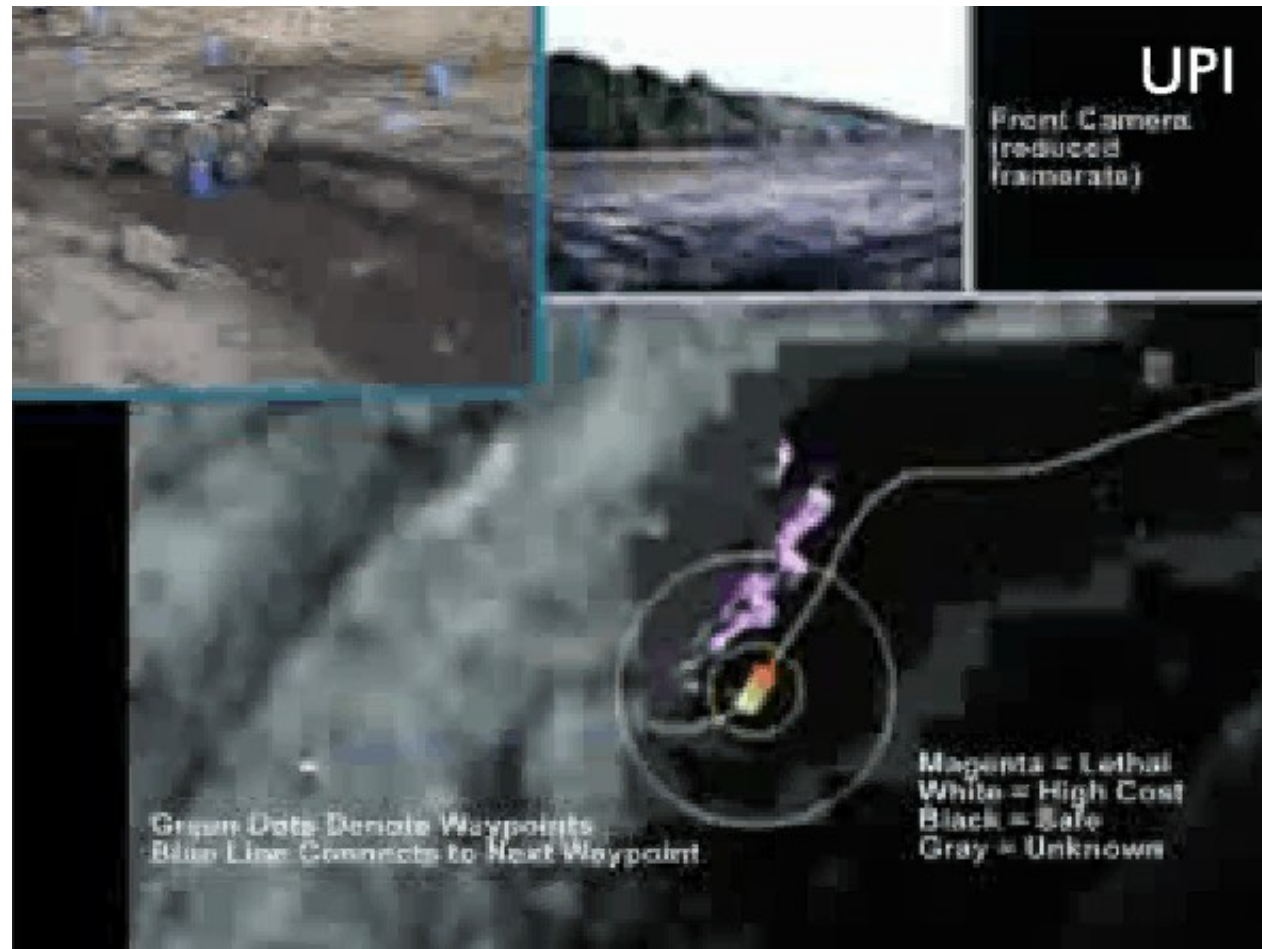
- Scanning lasers
- Stereoscopic cameras

■ Compute

- Extract features from sensor data
- Aggregate features into a world model

■ Act

- Plot a path in the world model that achieves some goal
- Monitor progress along path and adjust as needed



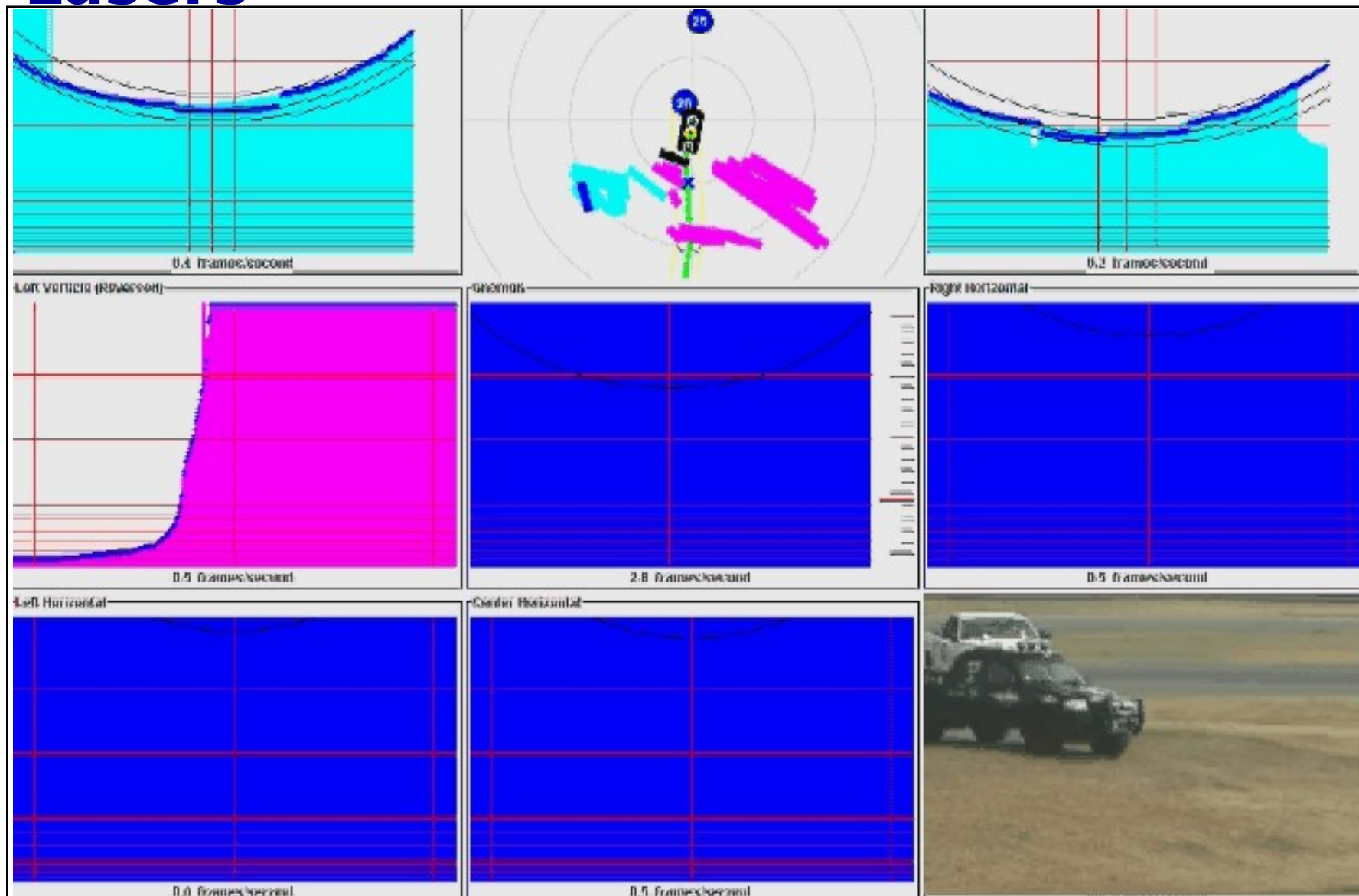
Robots are not People

- **People have highly evolved spatial sensing and reasoning**
 - Well suited to a 3D arboreal environment
 - Can coordinate multiple manipulator trajectories
 - So fundamental to our consciousness that we forget about it
 - Short comings are not apparent
 - The world is shaped by us to meet our needs
- **Robots also have advanced spatial capabilities**
 - Well suited to particular target environments
 - Often highly tuned to exploit subtleties
- **Changes in target application can make robots seem stiff**
 - We are not surprised to see a child jump rope and then play hopscotch
 - A contractor would cry foul if you told him to build a rope-skipping robot and then asked to see it throw horseshoes

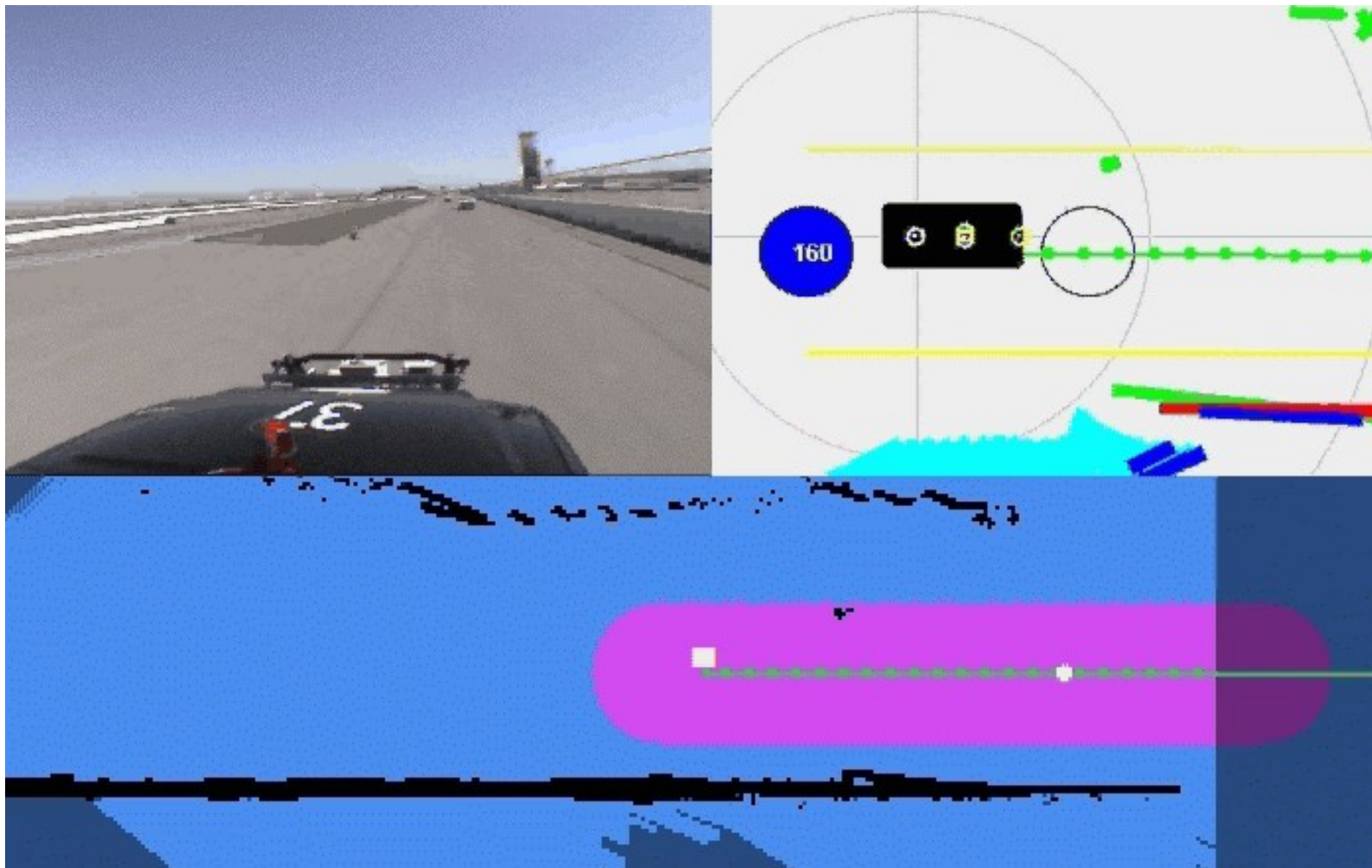


The forces that built you are not the same ones that build robots

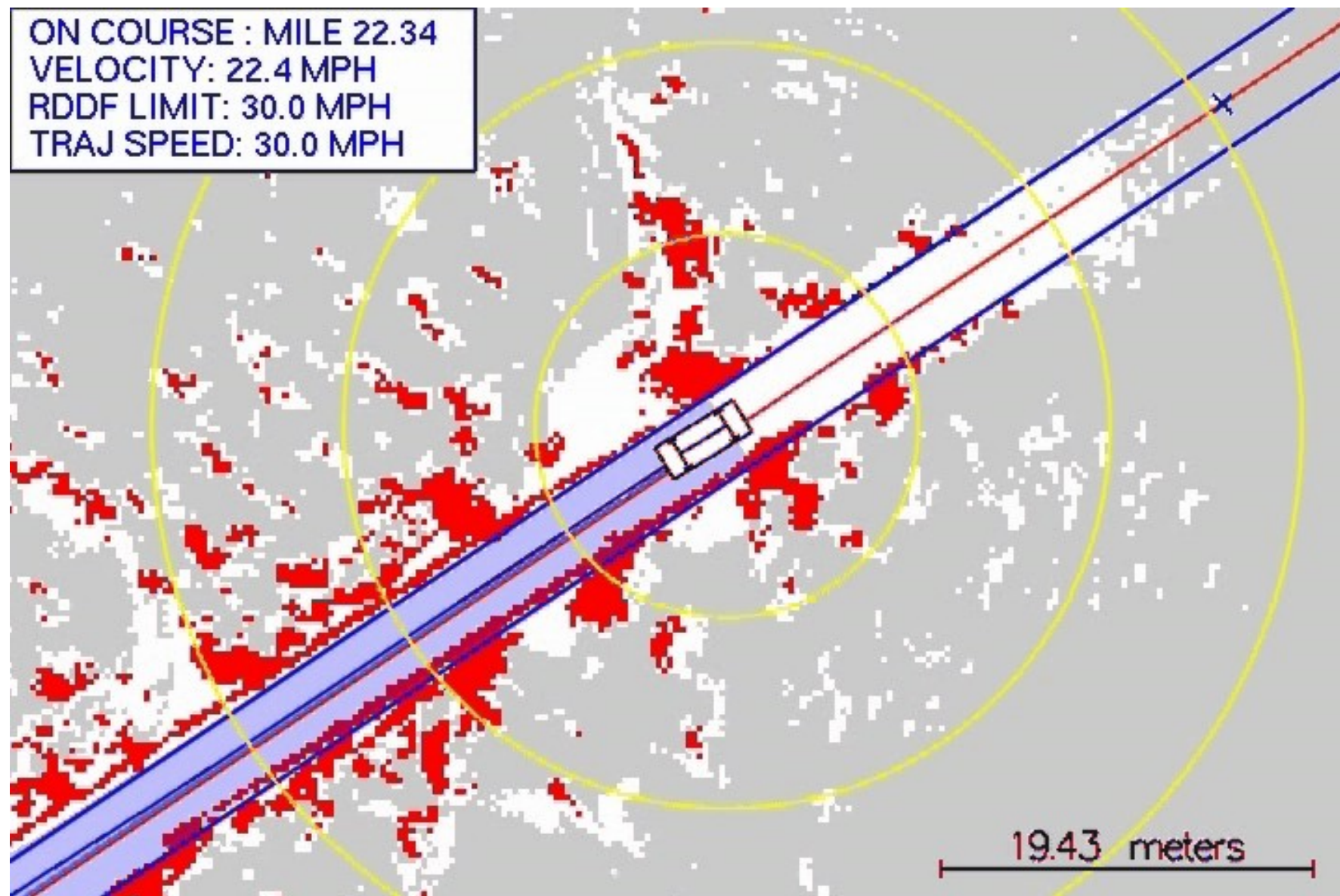
Extracting Features from Scanning Lasers



Acting on a World Model

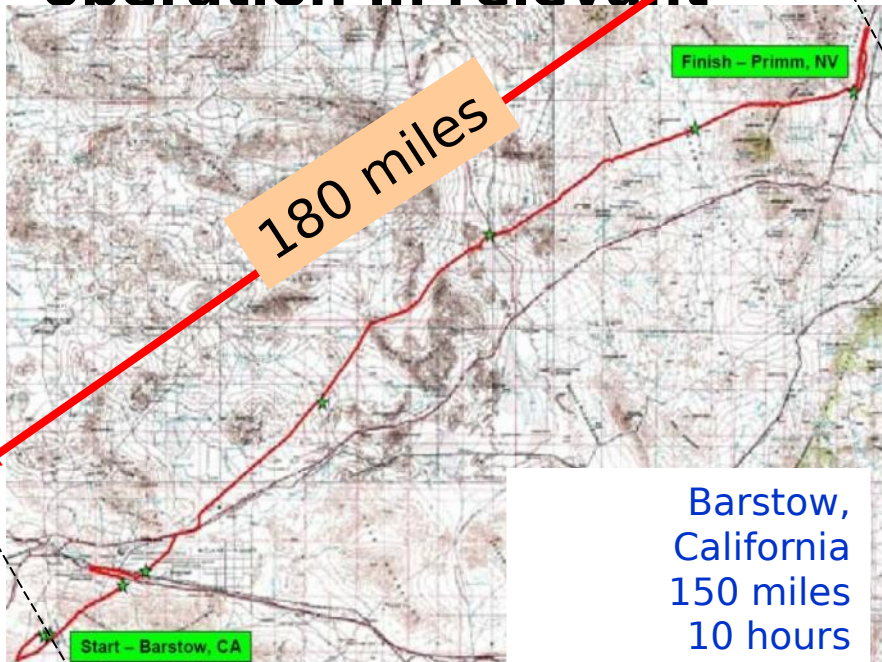


Fusing Sensors - A Strange Result



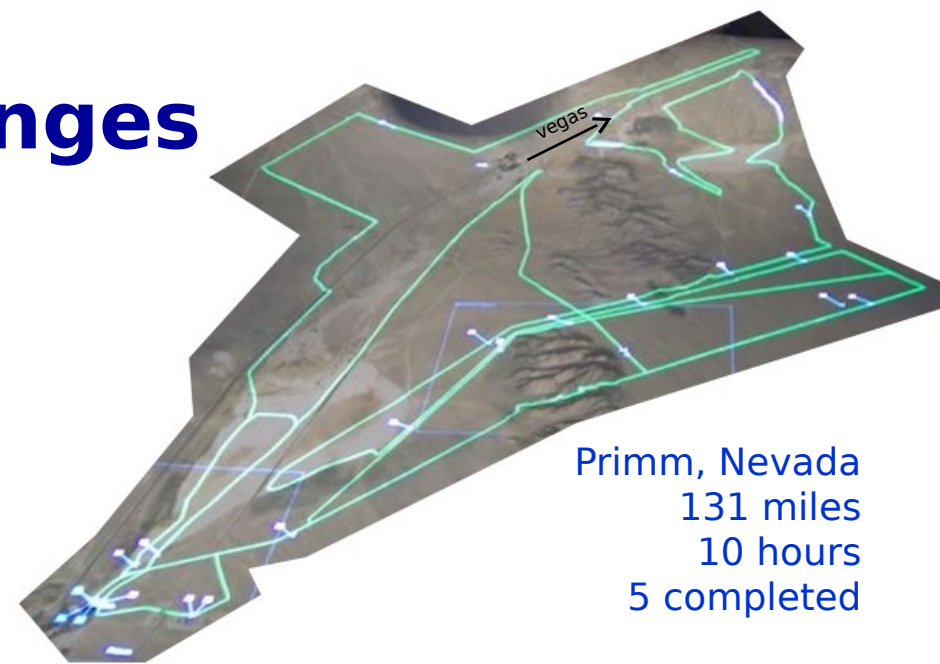
DARPA Grand Challenges

- Three challenges, 2004, 2005, 2007
- Open to public, academia, industry
- Mission focused - unmanned operation in relevant



Barstow,
California
150 miles
10 hours
Farthest = 7m

2004 DARPA Grand Challenge



Primm, Nevada
131 miles
10 hours
5 completed

2005 DARPA Grand Challenge



Victorville, California
6 hrs, 60 miles
Moving vehicles
6 completed

2007 Urban Grand Challenge

National Qualifying Event

2005 DARPA Grand Challenge



Obstacle Zone



Parked Car



Tire Poles



Tunnel



Open Run



Haybales



Hill



Mountain Pass



Traffic



Tank Trap



Gates



Start



Rumble Strips

43 teams
10 days of testing
12 Sequential tests
2.7 mile course

This Should Be Easy



Even the Finishers Had Trouble



2 Years Later



Merging into Traffic



Negotiating Parked Cars



Sky View of Course



1 and 2 lane Roads



Traffic Jam at Intersection

- Victorville Ca
- 60 miles
- 6 hours
- 3 missions



Large and Small

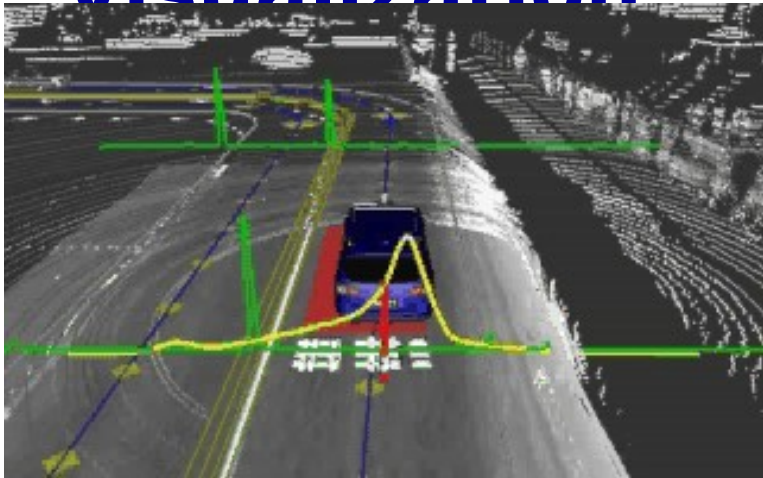


Passing Traffic

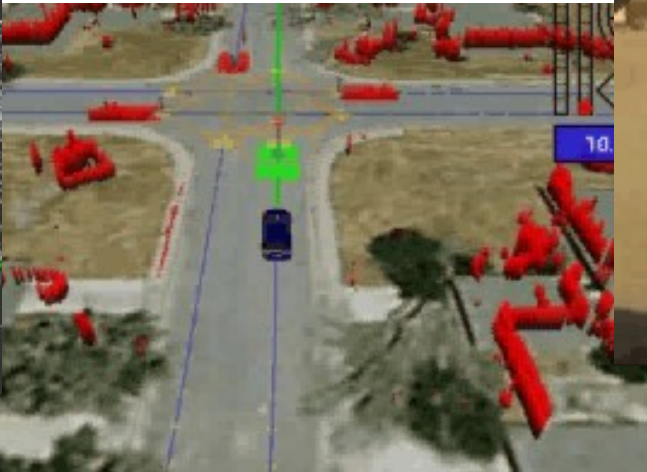


Taking Turns

Better Sensing, Better Visualization



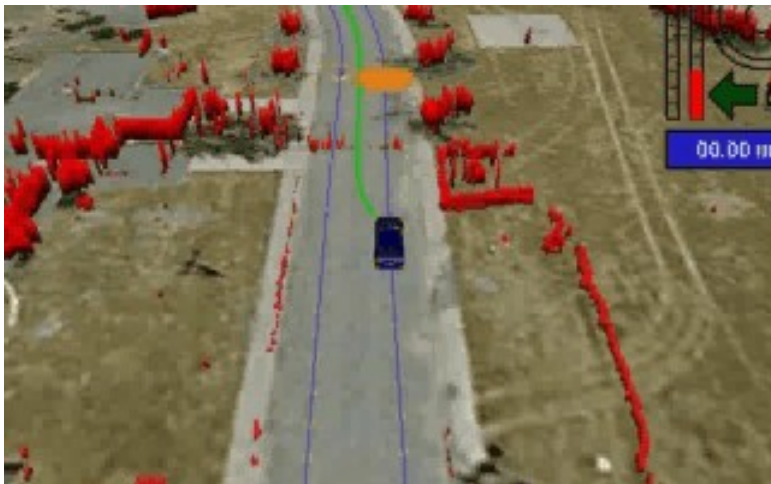
Finding the lane



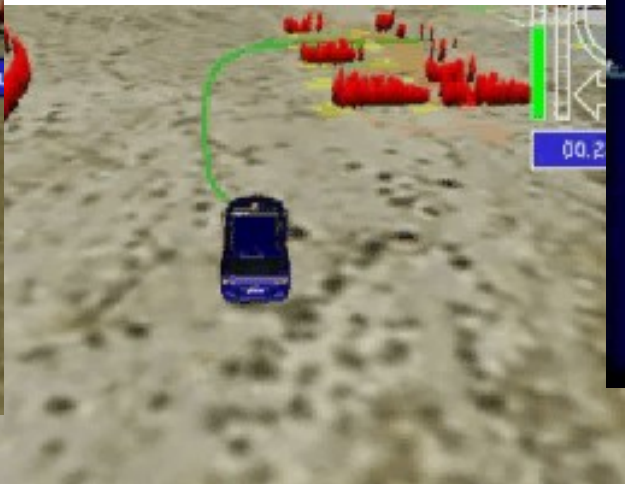
Intersection Precedence



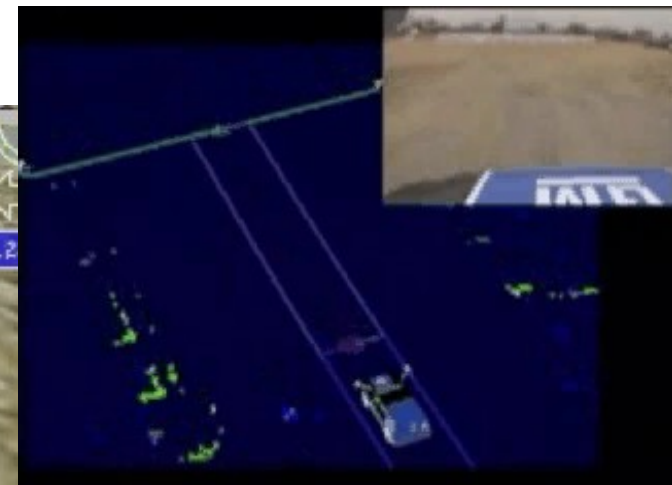
Obstacle Detection



Replanning around Blocked Roads



Parking



Parking

Still Working Out the Bugs



Wall Crash



Swerve



Curb Jump

Robot on
Robot
Collision



Curb Climb



Wall Crash

Building Crash

Wall Climb